

CHAPTER II — RECONNAISSANCE & COMMUNICATION

1. GENERAL

The foundation of any good tropical cyclone warning is accurate and timely fixes. Because of the vastness of JTWC Guam's area of responsibility and the limited number of land or ship reporting stations, JTWC must rely on two primary means of fixing tropical cyclones, namely aircraft and satellite. Aircraft reconnaissance and satellite derived data provided approximately 88 percent of the required fix data in 1974. This year saw greatly increased utilization of DMSP data with satellite data providing the basis of 44 percent of the warning positions. This increase was primarily a result of the variable warning time, which allowed more flexibility in reconnaissance planning and increased usage of DMSP data.

2. RECONNAISSANCE RESPONSIBILITY AND SCHEDULING

Aircraft weather reconnaissance is performed in the JTWC area of responsibility by the 54th Weather Reconnaissance Squadron (54 WRS). The squadron, presently equipped with eight WC-130 aircraft, is located at Andersen Air Force Base, Guam. The JTWC reconnaissance requirements are sent daily during the typhoon season to the Tropical Cyclone Aircraft Reconnaissance Coordinator. These requirements include areas to be investigated, fix times and forecast position of cyclones to be fixed at those times.

Four fixes per day, at six-hourly intervals, are required (CINCPACINST 3140.1M) on all significant tropical cyclones in the JTWC primary area of responsibility (see inside front cover). Two fixes per day are required in the secondary area of responsibility. During the 1974 season, increased use was made of the Selective Reconnaissance Program (SRP) to fulfill these requirements. The SRP was implemented in 1972 to alleviate pressure on overtaxed aircraft reconnaissance assets. The SRP attempts to optimize the entire reconnaissance system by using each reconnaissance platform (aircraft, satellite, and surface radar) to its full potential. Various factors are considered in selecting which reconnaissance platform to use for any warning, e.g., the cyclone's location and stage of development, the DMSP orbit times and areal coverage, availability of land radar reports, the cyclone's threat to U.S. interests, aircraft operational limitations (e.g., one-fix versus two-fix mission), etc.

Use of the variable warning time was instrumental during the 1974 season in optimizing use of DMSP satellite data. Warnings were scheduled within two hours of the standard warning times with the constraint that no more than seven hours may elapse between two consecutive warnings. Thus, JTWC often was able to use satellite fixes which would not have been timely under a less flexible warning system as a basis for many warnings.

Aircraft reconnaissance remains the only method of accurately determining measurable storm parameters. Only the aircraft can provide direct measurements of height, temperature, flight level winds, sea level pressure, and numerous other parameters. These data are vital to the forecaster for indications of changing cyclone characteristics, thus providing a broader basis for tropical cyclone warnings. The aircraft also provides much greater flexibility in time and space compared to the other platforms.

DMSP satellites provide day and night coverage of the JTWC area of responsibility. Interpretation of DMSP satellite imagery provides estimates of cyclone positions and, for daytime passes, estimates of intensities using the DVORAK Technique (NOAA TECHNICAL MEMORANDUM, NESS-45). A major disadvantage of the satellite is that until a storm has an eye, fix positions can vary significantly depending on the analyst, thus creating possible confusion as to the actual movement of the cyclone. In addition, satellites provide no direct measurements of parameters related to cyclone intensity nor do they give any reliable indication of various wind radii.

Land radar provides useful positioning data on well developed cyclones when in the proximity (usually within 200 nm of radar position) of the Republic of Philippines, Hong Kong, Taiwan, or Japan (including the Ryukyus). Radar does not, however, provide measurements or estimates of tropical cyclone intensity. Subsequent sections summarize the JTWC utilization of the various reconnaissance platforms during 1974.

3. AIRCRAFT RECONNAISSANCE EVALUATION CRITERIA

The following criteria are used to evaluate reconnaissance support to JTWC.

a. Six-hourly fixes - To be counted as made on time, a fix must satisfy the following criteria:

(1) Fix must be made not earlier than 1 hour before, nor later than 1/2 hour after scheduled fix time.

(2) Aircraft in area requested by scheduled fix time, but unable to locate center due to:

- (a) Cyclone dissipation; or
- (b) rapid acceleration of the cyclone away from the forecast position.

(3) If penetration not possible due to geographic or other flight restrictions, aircraft radar fixes are acceptable.

b. Levied 6-hourly fixes made outside the above limits are evaluated as follows:

(1) Early-fix is made within the interval from 3 hours to 1 hour prior to scheduled fix times; however, no credit will be given for early fixes made within 3 hours of the previous fix.

(2) Late-fix is made within the interval from 1/2 hour to 3 hours after scheduled fix time.

c. When 3-hourly fixes are levied, they must satisfy the same time criteria discussed above in order to be classified as made on time. Three-hourly fixes made that do not meet the above criteria are classified as follows:

(1) Early-fix is made within the interval from 1 1/2 hours to 1 hour prior to scheduled fix time.

(2) Late-fix is made within the interval from 1/2 hour to 1 1/2 hours after scheduled fix time.

d. Fixes not meeting the above criteria are scored as missed.

e. Levied fix time on an "as soon as possible" fix is considered to be:

(1) Sixteen hours plus estimated time enroute after an alert aircraft and crew are levied; or

(2) Four hours plus estimated time enroute after the DTG of message levying an ASAP fix if an aircraft and crew, previously alerted, are available for duty.

f. Investigatives - to be counted as made on time, investigatives must satisfy the following criteria:

(1) The aircraft must be within 250 nm of the specified point by the scheduled time.

(2) The specified flight level and track must be flown.

(3) Reconnaissance observations are required every half-hour in accordance with AWSM 105-1. Turn and mid-point winds shall be reported on each full observation within 250 nm of the levied point.

(4) Observations are required in all quadrants unless a concentrated investigation in one or more quadrants has been specified.

(5) Aircraft must contact JTWC before leaving area of concern.

g. Investigatives not meeting the time criteria of paragraph f, will be classified as follows:

(1) Late-aircraft is within 250 nm of the specified point after the scheduled time, but prior to the scheduled time plus 2 hours.

(2) Missed-aircraft fails to be within 250 nm of the specified point by the scheduled time plus 2 hours.

4. AIRCRAFT RECONNAISSANCE SUMMARY

Aircraft reconnaissance was levied 351 times to make six-hourly fixes on tropical cyclones in 1974. This is an increase of 124 levied fixes over 1973 and represents 66% of the levied six-hourly fixes before the cyclone passed the no-fly line. The remaining required fixes were levied against satellite (32.5%) or land radar (1.5%) as available. The increase in levied aircraft fixes during 1974 was due to the much higher level of tropical cyclone activity compared to 1973 (the year of lightest activity since JTWC was established in 1959). Nevertheless, the percentage increase in levied six-hourly aircraft fixes from 1973 to 1974 (54.6%) was significantly less than the percentage increase in warnings (68.5%) due to the greater use of DMSP data for fixes during 1974.

In addition to the levied six-hourly fixes, 30 investigatives and 7 intermediate fixes were levied by JTWC in 1974. The use of DMSP satellite data in conjunction with synoptic data resulted in only 4 levied investigatives on suspect areas that did not develop into tropical cyclones.

Table 2-1 summarizes reconnaissance effectiveness. Using the scoring criteria in Section 3, the 30 missed fixes (or 8.4% of the total levied fixes) represent a slight increase over 1973. Significantly, approximately one-half of the 1974 missed fixes occurred after mid-October, when the 54th Weather Reconnaissance Squadron was reduced to eight aircraft.

TABLE 2-1. AIRCRAFT RECONNAISSANCE EFFECTIVENESS

	NUMBER OF FIXES	PERCENT
COMPLETED ON TIME	292	81.5
EARLY	1	.3
LATE	35	9.8
MISSED	30	8.4
TOTAL	358	100.0

LEVIED VS. MISSED FIXES

	LEVIED	MISSED	PERCENT
AVERAGE 1965-1970	507	10	2.0
1971	802	61	7.6
1972	624	126	20.2
1973	227	13	5.7
1974	358	30	8.4

5. RADAR RECONNAISSANCE SUMMARY

The 1974 typhoon season produced the largest number of radar reports ever received at JTWC during a single season. A total of 997 radar reports of tropical cyclone positions were received; 995 from land stations¹ and 2 from aircraft. No ship radar reports were received during the 1974 Typhoon season. The large number of radar reports is primarily a result of the track and speed of the storms. Of the sixteen tropical storms and typhoons that came under the surveillance of radar, seven,

Gilda, Jean, Mary, Polly, Rose, Shirley, and Wendy, had tracks within radar range of Japan and the Ryukyu Islands, where the Japanese Meteorological Agency has established an extensive and highly reliable radar network. These seven storms accounted for 78% of all radar reports. Typhoon Shirley, which slowly meandered from central Ryukyus to southern Japan, alone accounted for 225 reports, nearly 23% of the total. During one period, Typhoon Polly was simultaneously surveyed by five radar sites.

To evaluate the quality of the 1974 radar data, the land radar reports were separated into the three categories of accuracy defined in the WMO radar code. These categories are: good (within 10 km; 5.4 nm), fair (within 10-30 km; 5.4-16.2 nm) and poor (within 30-50 km; 16.2-27 nm). Of the 995 reports, 34% were good, 38% were fair and 28% were poor. Consideration of radar reports made only while storms were of typhoon intensity yielded 45% in the good category. All land radar reports were compared to the JTWC best track position and the mean deviation was 12.0 nm. This is identical to the mean deviation obtained during the 1973 season which utilized only 409 land radar reports. The mean deviation of radar reports taken while storms were of typhoon intensity was also 12.0 nm.

Of the 995 land radar reports, 75.3% were obtained from sites in Japan and the Ryukyu Islands, 17.0% from the Philippines, 6.4% from the Royal Observatory at Hong Kong, 0.5% from Taiwan and 0.4% from each Guam and Korea. Although Hong Kong exhibited only a small percentage of reports, these provided valuable positioning information for 6 storms west of the Air Weather Service no-fly line. Sites in Taiwan and Korea provided similar information for Lucy and Wendy. Radars of National Meteorological Agencies accounted for 64% of all reports, AC&W sites 12% and Air Weather Service stations 24% (primarily from Kadena AFB, Okinawa and Clark AFB, Philippines), a 16% increase over the 1973 AWS contribution.

Communication problems in the Philippines resulted in the absence of any radar reports during the passages of Bess and Elaine across northern Luzon, although the storms were within range of four radar sites and very close to two of these. There remains a critical need for radar coverage on the east coast of Luzon and in the Luzon Straits. Hopefully, the site at Catanduanes Island and a new site (BASCO) in the Bataan Islands will be operational by the latter part of the 1975 Typhoon season.

6. SATELLITE RECONNAISSANCE SUMMARY

The use of DMSP satellite data for tropical cyclone reconnaissance provided by U.S. Air Force DMSP sites increased dramatically during 1974. The levy rate for satellite fixes increased to 32.5% compared with 15.4% in 1973. Since there are a number of situations each year when a choice of platforms is not possible (e.g., when cyclones are past the no-fly line near the Asian coast), the actual use rate of

- 1 A list of land radar sites is located in the "Tropical Cyclone Center Fix Data" portion of this report.

DMSP data for warnings is always significantly higher than the levy rate. During 1974, the use rate increased to 43.8% from 27.4% in 1973. Three factors are responsible for this large increase in the use of satellite data. First, 1974 was a much more active season than 1973, placing a much greater load on available aircraft reconnaissance assets. Selectively using DMSP data for many fixes takes some pressure off the aircraft reconnaissance resources and helps insure that aircraft fixes will be available when needed most. Second, there were always at least two DMSP spacecraft operational during 1974 and during the heart of the primary season (August through November) data were available from three satellites. Thus, during 1974, satellite coverage was available for 88% of the six-hourly warning cycles compared to only 58% during 1973. The third and dominant factor in the increased use of satellite data was the use of the variable warning time option described in Chapter I.

The DMSP satellite network continued to operate smoothly during 1974. DMSP sites made 1203 position estimates on tropical cyclones in the western North Pacific area compared with 605 during 1973. Once-daily intensity estimates derived from the Dvorak technique (NOAA TM, NESS-45) were also computed. Additionally, hundreds of other satellite analyses were made on tropical disturbances and tropical cyclones in their pre-warning stages. The primary network sites during 1974 were Nimitz Hill, Guam; Fuchu, Japan; and Nakon Phanom, Thailand (NKP). Kadena, Japan and AFGWC served as backup sites for the western North Pacific. Additionally, NKP and AFGWC provided DMSP coverage of tropical cyclone activity in the Bay of Bengal. Late in 1974, the Fuchu site was relocated to Yokota Air Base, Japan. The Kadena site has been returned to a fully operational status and will be a primary site during the 1975 season.

DMSP derived positions of tropical cyclones are separated into six classes according to the method of gridding and type of apparent circulation center. These classes are identified by the Position Code Number (PCN) system shown below.

PCN	CLASS
1	Visible Eye/Geographical Gridding
2	Visible Eye/Ephemeris Gridding
3	Well Defined Circulation Center/Geographical Gridding
4	Well Defined Circulation Center/Ephemeris Gridding
5	Poorly Defined Circulation Center/Geographical Gridding
6	Poorly Defined Circulation Center/Ephemeris Gridding

Each derived DMSP position is compared to the JTWC best track position for the corresponding time. The mean deviations between the satellite positions and best track positions for the past three years are shown in Table 2-2. The statistics for 1973 and 1974 are for all sites because the DMSP

satellite network was operational for these years. The statistics for 1972, however, are limited to the Guam site since only positions from the Guam sites were used in the Selective Reconnaissance Program that year and standardized positioning techniques had not been made available to all sites.

Table 2-2. Mean Deviations (nm) of DMSP Derived Tropical Cyclone Positions from JTWC Best Track Positions, 1972-1974. Number of cases shown in parentheses.

PCN	1972 (GUAM)	1973 (ALL SITES)	1974 (ALL SITES)
1	14.2(104)	15.5(129)	13.6(224)
2	15.8(53)	20.0(17)	17.4(37)
3	21.3(100)	20.3(252)	20.1(422)
4	20.2(39)	20.0(24)	23.9(70)
5	29.9(137)	45.9(163)	35.4(342)
6	30.4(157)	29.6(20)	49.4(108)
1&2	14.7(157)	16.0(146)	14.2(261)
3&4	21.0(139)	20.3(276)	20.6(492)
5&6	30.2(294)	44.1(183)	38.8(450)
TOTAL	23.9(590)	26.4(605)	26.0(1203)

The increase in the mean deviations of the poorly defined cases (PCN 5&6) in 1973 and 1974, compared to 1972, is significant. With more experience in DMSP data interpretation and use of various thresholding techniques to amplify the mesoscale features near the cyclone's circulation center, many of the cases that would have been classified as poorly defined in 1972 could be classified as well defined in 1973 and 1974. This did not increase the mean deviations in the well defined category (PCN 3&4); however, it did increase the mean deviations in the poorly defined category since cases in this category during 1973 and 1974 were truly poorly defined. The percent of cases in the poorly defined category was 50% in 1972, 30% in 1973, and 37% in 1974. Poorly defined cases are much more frequent at night due to the coarser resolution of the infrared sensors, e.g., during 1974, 50% of night cases were poorly defined compared to 26% of the daytime cases. The percent of cases with visible eyes (PCN 1&2) has remained relatively stable: 27% in 1972, 24% in 1973, and 22% in 1974.

The 1974 positioning statistics for the individual DMSP sites are given in Table 2-3. There is little difference among the sites in positioning accuracies. These statistics and those in Table 2-2 indicate that the DMSP PCN classification system is stable, reliable, and reproducible by independent analysts following standardized guidance (1 WWP 105-10, Tropical Cyclone Position and Intensity Analysis Using Satellite Data).

Once-daily tropical cyclone intensity estimates are made from the daytime DMSP data using the Dvorak technique. This technique assigns a Current Intensity (CI) number to the cyclone depending on the cyclone's Central Features (CF), Banding Features (BF), and continuity considerations from previous analyses. Following are the Maximum Wind Speeds (MWS) associated with each CI number.

Table 2-3. Mean Deviations (nm) of DMSP Derived Tropical Cyclone Positions from JTWC Best Track Positions for Western North Pacific DMSP Sites during 1974. Number of cases shown in parentheses.

PCN	GUAM	YOKOTA	NAKON	PHANOM	KADENA
1&2	12.6(116)	15.7(72)	14.3(36)	11.7(26)	
3&4	20.0(231)	21.3(175)	19.6(54)	18.7(24)	
5&6	35.4(206)	46.2(118)	37.0(94)	38.5(31)	
TOTAL*	24.2(553)	28.3(365)	27.5(184)	24.0(81)	

*20 less than 1974 totals in Table 2-2 which includes some positions from AFGWC.

CI	MWS(Knots)	CI	MWS(Knots)	CI	MWS(Knots)
1.5	25	4.0	60	6.5	122
2.0	30	4.5	72	7.0	135
2.5	35	5.0	85	7.5	150
3.0	40	5.5	97	8.0	170
3.5	50	6.0	110		

Figure 2-1 shows a comparison of the derived intensities with the JTWC Best Track (BT) intensities for 1974. The BT intensities were placed into the closest corresponding CI category and deviations computed according to CI numbers. Overall, 74% of the cases fell within ± 0.5 CI number and 91% of the cases within ± 1.0 CI number. There was a tendency for the DMSP intensity estimates to be slightly higher than the BT wind speeds.

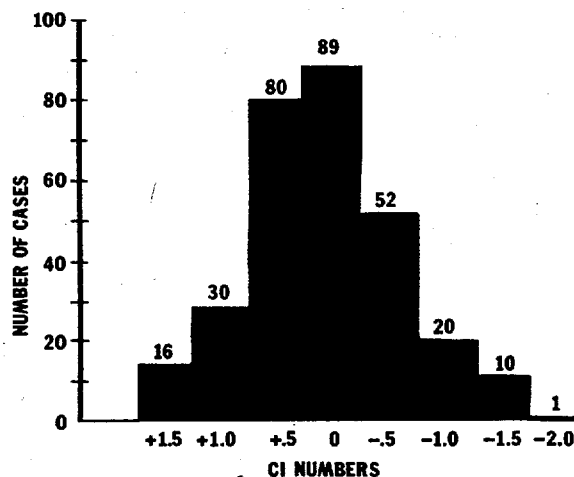


FIGURE 2-1. Comparison of derived CI number* and JTWC BT intensities.

*Nimitz Hill site only

The greatest benefit from DMSP data has been the significant increase in JTWC's ability to forecast tropical cyclone development. By carefully monitoring daily changes in tropical disturbances, JTWC can normally give at least 12 to 24 hours notice that a significant tropical cyclone

is developing. When development during the next 24 hours is judged likely, a tropical cyclone formation alert is issued giving the current location, the estimated maximum winds in the disturbance, and the area where development is likely to occur. Formation alerts are updated as necessary until the cyclone is picked up in warning status or canceled if the disturbance fails to develop. Table 2-4 shows the verification rate of tropical cyclone formation alerts for the past five years. A significant increase in the verification rate occurred in 1971, the first season for which DMSP data was available. Subsequent increases can be attributed to increased skill in interpreting the DMSP imagery and close integration of satellite and conventional meteorological data.

Table 2-4. VERIFICATION SUMMARY FOR TROPICAL CYCLONE FORMATION ALERTS

YEAR	NUMBER OF ALERT SYSTEMS	ALERT SYSTEMS WHICH BECAME NUMBERED TROPICAL CYCLONES	TOTAL NUMBERED TROPICAL CYCLONES	DEVELOPMENT RATE
1970	32	18	27	56%
1971	48	33	37	69%
1972	41	29	32	71%
1973	26	22	23	85%
1974	35	30	35	86%

Due to the use of DMSP data to monitor tropical disturbances in their developing stages, the need for aircraft investigative flights has been greatly reduced resulting in considerable savings of aircraft reconnaissance resources in recent years. Table 2-5 presents a summary of levied investigative flights during the past five years. During the past two years, the ratio of levied investigative flights to the total number of tropical cyclones has been near unity. In most cases during 1973 and 1974, the investigative flight provided the basis for the first warning on the tropical cyclone.

Table 2-5. SUMMARY OF AIRCRAFT INVESTIGATIVE FLIGHTS

YEAR	LEVIED INVESTIGATIVE FLIGHTS	TOTAL TROPICAL CYCLONES	RATIO
1970	170	27	6.3-1
1971	179	37	4.8-1
1972	81	32	2.5-1
1973	28	23	1.2-1
1974	30	35	0.9-1

Some simple calculations illustrate the magnitude of aircraft reconnaissance savings

during the developing, pre-warning stages of tropical cyclones. Multiplying the average ratio of investigative flights to tropical cyclones experienced during 1970 and 1971 of 5.5 to 1 times 34 (the average yearly number of tropical cyclones including tropical depressions) results in a requirement of 187 investigative flights in an average year without DMSP data. With DMSP data a ratio of unity can be achieved requiring only 34 investigative flights in an average year. Thus, average savings of 153 investigative flights per year can be achieved. A normal 10 to 12 hour investigative flight is equivalent to a mission making two consecutive six-hourly fixes. Thus, an equivalent savings of 306 six-hourly fixes are realized. When this figure is compared to the average number of levied six-hourly fixes (534) during the last 10 years, the large savings of aircraft resources during the early developing stages of tropical cyclones becomes evident. This use of DMSP data during the pre-warning stages of cyclones and selective use of DMSP data for six-hourly fixes once a cyclone has developed helps explain why the large reductions in aircraft reconnaissance assets have not yet degraded the tropical cyclone warning service. The primary problem facing JTWC in future years will be to optimize the mix of reconnaissance assets so that the maximum capabilities of each resource can be realized.

DMSP satellites have become a vital part of the tropical cyclone warning system during the past few years. Their loss now that the aircraft reconnaissance assets have been drastically reduced would seriously degrade JTWC's warning capabilities. The overall use of DMSP satellite data for warnings should increase in future years; however, the very large increase in satellite use from 1973 to 1974 was due primarily to the one-time benefit of the variable warning time option and increases in future years will probably be at a much slower rate. Also, the potential DMSP satellite use rate is heavily dependent on the number and orbit time of the satellites. During periods when only one DMSP satellite is operational, the potential use rate drops sharply and JTWC's flexibility in optimizing a mix of aircraft and satellite data is greatly reduced.

7. COMMUNICATIONS

a. AIR TO GROUND

Aircraft reconnaissance data are normally received by JTWC via direct phone patch through Andersen Aeronautical Station, which is the primary station for this purpose. Under degraded radio propagation conditions, the Clark or Fuchu aeronautical stations can intercept and relay the data via AUTOVON and teletype to JTWC.

Average communication delays for the preliminary and complete center data messages for past years are compared with 1974 delays in Figure 2-2. Delay times are defined as the difference between the fix time and the time of message receipt at JTWC. The preliminary fix message continued to prove its effectiveness by permitting a significant amount of extra time to be spent in forecast preparation.

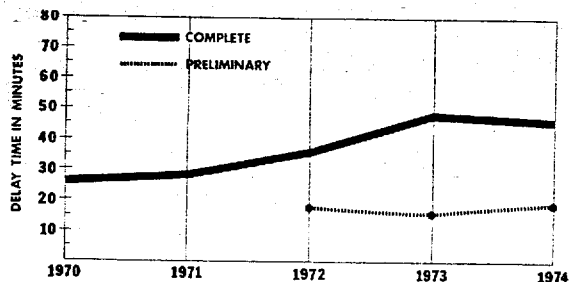


FIGURE 2-2. DELAY TIMES - Receipt of eye data messages.

Table 2-6 depicts the complete center data messages received more than one hour after fix time and after warning time. The decrease in the latter can be directly attributed to the variable warning time introduced in 1974.

TABLE 2-6. 1974 AIR/GROUND DELAY STATISTICS FOR AIRCRAFT RECONNAISSANCE COMPARED WITH PREVIOUS YEARS

	1970	1971	1972	1973	1974
% Complete fix messages delayed over one hour	5	6	6	20	19
% Complete fix messages received after warning time	0.9	2.1	5.5	10.1	4.9

b. SELECTIVE RECONNAISSANCE PROGRAM

With the advent of the SRP, the importance of radar and satellite fix data has increased considerably over previous years. A review of the associated communication delays follows with delay times defined as the difference between the observation time and the time of message entry into the AWN. In contrast to previous years, radar reports were received in a very timely manner. Data from the AC&W radar sites in the Philippines and data from nationally operated radars of the Republic of China, Hong Kong, Japan, and the Republic of the Philippines were delayed an average of only 20 to 35 minutes. In the worst cases, JTWC still received the messages within 80 minutes of observation time. Tropical cyclone radar data is routed to JTWC over the AWN through the use of a special high precedence collective indicator. Additionally the AC&W radar reports were phoned to JTWC from Clark AB, thereby providing the information somewhat earlier than indicated.

Over 1557 position and intensity estimates were derived from Air Weather Service (AWS) DMSP sites and the aircraft

carrier USS CONSTELLATION during 1974. The data from the AWS DMSP sites were immediately passed via AUTOVON followed by an AWN message. AUTOVON provided rapid communication of the essentials and a brief two-way discussion of the data (a benefit not possible by message). Average delay times of 65 minutes for telephone and 84 minutes for message resulted from a sampling of mid-season storms. These delay times are the difference between satellite equator-crossing time and the time of the telephone call or entry of the message into the AWN. Systematic differences in data processing time among the DMSP sites introduces small variations in the above figures which are independent of communications and analysis time.

c. OUTGOING COMMUNICATIONS

Messages originating at JTWC are processed by the Naval Telecommunications Center (NTCC) of the Naval Communications Station, Guam. By special agreement, all tropical cyclone warnings are placed in the communications system before pending IMMEDIATE precedence traffic. Manual processing is accomplished as though the warning had FLASH precedence. Warnings were delivered to the message center an average of 28 minutes before warning time. In Figure 2-3, yearly averages of the handling time are plotted relative to warning time as indicated by the length of vertical bars. Handling times for tropical depression warnings (not shown) were reduced from 25 minutes in 1973 to 9 minutes in 1974.

The dramatic improvement in handling time achieved during 1973 continued into 1974, thereby allowing the average message to be placed on the circuits before the established warning time. The time of receipt of a warning at a particular station depends on factors beyond the control of either JTWC or NTCC.

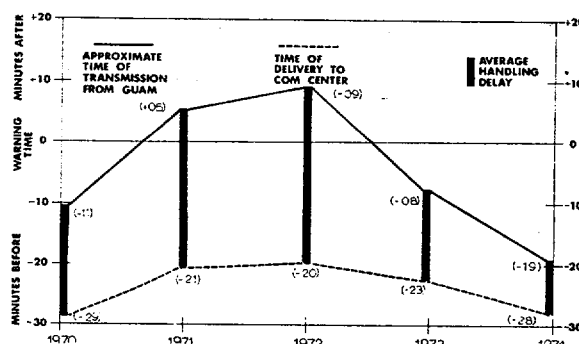


FIGURE 2-3. AUTODIN handling time data for typhoon and tropical storm warnings.